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| Version | Date | Description of Revisions |
| 1 | August 30, 2006 | Approved final document. |
| 2 | September 30, 2009 | Review/update of the document “Related Sections” |
| 3 | May 10, 2013 | First Draft – Consolidated Comments Spec Update Project |
| 4 | June 17, 2013 | Finalized for Legal Review. Incorporation of new Commissioning and Computerized Maintenance Management System Data Requirements Specification cross references. |
| 5 | June 2, 2014 | Incorporation of Legal’s comments and addition of details in order to address Legal’s comments (AV) |
| 6 | July 22, 2014 | Amended to reflect changes related to commissioning specification and name change (AV) |
| 8 | September 24, 2014 | Updated, Finalized Specification – Reference eDOCS #1029459-v5 (AV) |
| 9 | February 18, 2015 | Updated standards (AV) |
| 10 | March 2, 2015 | Updated, Finalized Specification – Legal Reference eDOCS #5043363 v12 (AV) |
| **11** | **March 18, 2016** | **Updated AWWA Standards** |
| 12 | March 1, 2017 | Updated for references to NSF 372. (AV) |

NOTE:

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

**Notice:** This Document hardcopy must be used for reference purpose only.

**The on-line copy is the current version of the document.**

# GEneral

## Scope of Work

### Under this Section, the Contractor shall supply all materials, equipment and labour necessary for the complete design, construction, mixing system installation, testing, disinfection and commissioning of an elevated water storage facility as specified in this Section. The Contractor is responsible for coordinating communications infrastructure that may be incorporated into the tank design given the prevalence of the use of such structures on elevated tanks.

### The Contractor shall conform to all Nav Canada, Transport Canada and any other relevant agency requirements for lighting, telecommunication and other relevant agency regulations *[Consultant to add applicable agencies that have regulations, permit requirements or any other requirements necessary to allow the construction and final use by the Region of the elevated water storage tank. Consultant to amend this specification as required]*.

### The Contractor shall obtain all approvals and permits required for such equipment in the construction of the elevated tank.

### The Contractor shall be responsible for conducting work in an environmentally responsible manner with minimal impact to the neighbouring community (if applicable) with respect to dust, noise, Site security etc.

### Only contractors who are fully experienced in the design, fabrication and erection of elevated water storage tanks shall be considered for this work.

## Related Sections

### [Under "Related Sections", identify other Sections that are related to, and/or dependent on, the work results or information specified elsewhere. The list should be limited to Sections with specific information that the reader might expect to find in this Section, but is specified elsewhere. For example, if hardware for aluminum entrances is specified in the aluminum entrance Section, a cross-reference would be appropriate in the finish hardware Section. The purpose of this cross-referencing is for information only, to aid in finding those other requirements—not to define the scope of the Section.

### Cross-referencing here may also be used to coordinate assemblies or systems whose components may span multiple Sections and which must meet certain performance requirements as an assembly or system.

### This Section is to be completed/updated during the design development by the Consultant. If it is not applicable to the section for the specific project it may be deleted.]

### [List Sections specifying installation of products supplied but not installed under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Execution requirements for ...[item]... specified under this Section.

### [List Sections specifying products installed but not supplied under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Product requirements for ...[item]... for installation under this Section.

### [List Sections specifying related requirements.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: [Optional short phrase indicating relationship].

#### Section 01060 – Regulatory Requirements

#### Section 01250 – Substitutions

#### Section 01300 – Submittals

#### Section 01425 – Computerized Maintenance Management System Data Requirements

#### Section 01750 – Disinfection and Testing of Water Retaining Structures and Process Piping

#### Section 01810 – Equipment Testing and Facility Commissioning

#### Section 01820 – Demonstration and Training

#### Section 03300 – Cast-in Place Concrete

#### Section 09660 – Painting of Steel Tanks and Appurtenances

#### Section 11010 – Equipment General Requirements

#### [Division 1 – General Requirements – insert applicable specifications]

#### [Division 3 - Concrete– insert applicable specifications]

#### [Division 8 – insert applicable specifications]

#### [Division 13 – insert applicable specifications]

## General Description

### The elevated water storage facility shall have a networking capacity of and be able to meet distribution system operating conditions in accordance with the operational requirements set out in Division 13 - SCADA and Instrumentation and the Process Narrative/Process Control Narratives included in the SCADA appendices, including water quality and water age: [\_\_\_\_\_] m3 (\_\_\_\_\_\_) Imperial gallons

*[Modify to suit individual project]*

### The top water level (TWL) shall be set at an elevation of [\_\_\_\_] m Above Mean Sea Level (AMSL) and the overflow level capacity level shall be 100 mm above this level. The maximum working range and the minimum height from ground level to tank low water level (LWL), shall be as detailed on the Contract Drawings for the Elevated Water Storage Tank.

### The mixing characteristics of the mixing system shall be assessed and reported by Computational Fluid Dynamics (CFD) methods provided by the Contractor who will engage an independent firm experienced and competent in CFD assessments. [Consultant and York Region staff will review the need for CFD assessment and amend the specification as required]. Submit the CFD assessment report to the Consultant for approval and the Region for sign-off. The mixing system must be able to withstand disinfection level chlorine residuals without any negative impact to the equipment and materials comprising the mixing system.

## Technical Definitions

### The following technical definitions shall apply to this Specification:

#### Annular Ring: Annular-shaped reinforced concrete slab foundation that bears directly on soil or rock. The centroid of the cross section of the annulus must be located at or near the centre-line radius of the support wall.

#### Mixing System: A system providing required mixing during tank level changes specifically designed to improve water quality and chlorine residual integrity of the tank volume impacting the distribution system.

#### Appurtenances: Piping, mechanical equipment, vents, ladders, safety devices, platforms, doors, lighting, and related items necessary for operation of the tank.

#### Accessories: Optional or additional equipment or components required by the Contract Documents.

#### Capacity: The net volume contained between the low water level and top water level. The zero level is to be defined in terms of volume of water available at the zero level (elevation) point of the elevated tank level meter.

#### Composite Elevated Tank: The entire tank structure comprising: the foundation, concrete support structure, steel tank, and appurtenances and accessories.

#### Concrete Support Structure: All concrete support elements above the top of the foundation: wall, ring-beam, and dome or flat slab tank floor (composite tanks).

#### Deep Foundation: Piles and pile cap that transfer load to competent soil or rock strata by end bearing, by skin friction or adhesion, or both.

#### Foundation: The concrete annular ring, raft, or pile or pile cap.

#### TWL, Top Water Level.

#### LWL (Low Water Level): The lowest water level in the tank under all normal tank operating conditions. This level shall not be below any silt traps.

#### Pile Cap: Reinforced concrete element that transfers load from the support wall to the supporting piles.

#### Raft Foundation: A reinforced concrete slab foundation that bears directly on soil or rock.

#### Ring-beam: The concrete element at the top of the wall, connecting the wall and dome, and the support for the steel tank cone. The ring-beam resists unbalanced thrust forces from the steel tank cone and tank floor dome (composite tanks)

#### Riser Piping: Inlet/outlet and overflow pipes, fittings, and appurtenances above the termination point near grade. The termination point near grade in the inlet/outlet pipe shall be the bottom flange in the vertical run of pipe or the bottom of the expansion joint when located near grade. The termination point near grade of the overflow will be the discharge point of the overflow.

#### Rustication: Shallow indentation in the concrete surface formed by shallow insert strips to provide architectural effect on exposed surfaces. Also referred to as “architectural relief”.

#### Service Loads: Un-factored design loads (including lighting and/or telecommunication equipment).

#### Shallow Foundation: Annular ring or raft foundation that transfers load to a competent soil or rock stratum by direct bearing.

#### Slab-on-Grade: Floor slab inside the wall at grade.

#### Steel Liner: A non-structural welded steel membrane placed over a concrete tank floor and welded to the steel tank to provide a liquid-tight container; is considered as part of the steel tank.

#### Steel Tank: The welded steel plate water containing structure comprised of all steel plate and structural elements attached to the concrete support structure (composite tanks)

#### Support Wall or Wall: The cylindrical concrete wall supporting the steel tank and its contents, extending from the foundation to the tank floor.

#### Strength Test: The average of the compressive strengths of two cylinders made from the same sample of concrete and tested at 28 days or at the test age designated for determination thereof.

#### Tank Floor: A structural concrete dome or flat slab that supports the tank contents inside the support wall. It includes the ring-beam used with a dome floor (composite tanks).

#### TWL (Top Water Level): The maximum water level in the tank under all normal tank operating conditions other than overflow.

## Reference Standards

### Comply with the latest edition of the following statutes, codes, standards, and all amendments (as applicable) thereto:

#### Ontario Regulations

##### Ontario Occupational Health and Safety Act, 1990

##### Ontario Regulation 213/91 Construction Projects as amended (O. Reg. 88/13).

##### Building Code Act, 1992. Ontario Regulation 221/12

#### National Building Code of Canada *[Consultant to confirm applicability of NBC in relation to provincial building codes]*.

#### Canadian Standards Association

##### CAN/CSA S16-14, Design of Steel Structures

##### CAN/CSA W47.1-09 (R2014), Certification of companies for fusion welding of steel

##### CAN/CSA W47.2-11, Certification of companies for fusion welding of aluminum

##### CAN/CSA A23.1-09 (R2014), Concrete materials and methods of concrete construction

##### CAN/CSA A23.2-09 (R2014), Test methods and standard practices for concrete

##### CAN/CSA A23.3-14, Design of Concrete Structures

##### CAN/CSA A23.4-09 (R2014), Pre-cast concrete - Materials and construction [as applicable]

##### CAN/CSA W59-2013, Welded steel construction (metal arc welding)

##### CAN/CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel.

##### CSA Z259.2.2-14, Self-retracting Devices

#### American Water Works Association

##### AWWA C652-11 - Disinfection of Water- Storage Facilities

##### AWWA D100-11 - Welded Carbon Steel Tanks for Water Storage.

##### AWWA D102-14 - Coating Steel Water- Storage Tanks.

##### AWWA D104-11 Automatically Controlled, Impressed Current Cathodic Protection for the Interior Submerged Surfaces of Steel Water Storage Tanks.

##### AWWA D106-10 – Sacrificial Anode Cathodic Protection Systems for the Interior Submerged Surfaces of Steel Water Storage Tanks.

##### AWWA D107-10 – Composite Elevated Tanks for Water Storage.

#### American Concrete Institute

##### ACI 117-10, Specification for Tolerances for Concrete Construction and Materials

#### American Society for Testing and Materials

##### ASTM A312/ A312M-14b, Standard Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes

##### ASTM A240/ A240M-15, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

##### ASTM A774/A774M-14, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

##### ASTM A778-01(2009)e1, Standard Specification for Welded, Un-annealed Austenitic Stainless Steel Tubular Products

##### ASTM A380/A380M-13, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel parts, Equipment, and Systems

#### NSF International (NSF)

##### NSF/ ANSI Standard 61: Drinking Water System Components- Health Effects

##### NSF 372-2011: Drinking Water System Components – Lead Content

#### National Association of Corrosion Engineers International

##### NACE RP0178-2007 – Design, Fabrication and Surface Finish Practices for Tanks and Vessels to be Lined for Immersion Service.

#### Design Guidelines for Drinking Water Systems (MOE 2008).

#### American Society Mechanical Engineers (ASME)

##### B36.10M-2004, Welded and Seamless Wrought Steel Pipe

#### Society for Protective Coatings

##### SSPC - Systems and Specifications, SSPC Painting Manual, Volume 2

##### SSPC-PA 1 – Shop, Field and Maintenance Painting of Steel

##### SSPC-PA 2 – Procedure for Determining Conformance to Dry Coating Thickness Requirements

#### ECCS (European Convention for Constructional Steelwork)

##### Buckling of Steel Shells– European Design Recommendations, 5th Edition, Revised Second Impression, 2013

## Related Sections

### All Divisions of the Contract are related to this Section.

## Submittals

### General:

#### The Contractor shall prepare and submit all required documentation and samples as specified in Division 1 – General Requirements of these specifications. In addition, the Contractor shall submit all additional documentation as specified in this Section.

### Submittals:

#### The Contractor shall submit a design brief *[Consultant to ensure that the scope and requirements of the design brief is clearly spelled out in the Contract Documents. Consultant to define when in the project schedule the design brief is to be submitted after award of the Contract)]* and preliminary drawings. The preliminary drawings shall show all major dimensions of the foundation, support structure and steel tank, wall/slab thicknesses, plate thicknesses and high/low water levels. The submission shall also include a description including photographs of the architectural finish (rustication) to be used for the concrete support structure, if applicable.

#### The Contractor shall submit complete foundation, tank construction, erection, and shop drawings as well as design calculations which shall bear the certification of a professional engineer licensed to practice in the Province of Ontario and experienced in the design of water storage facilities. This submittal is due within [56] Working Days of the date of award of the Contract. The Contractor shall allow 15 Working Days for review and acceptance by the Consultant which shall be obtained before proceeding with fabrication.

#### The required design and analytical procedures shall quantify all of the structural effects and loading conditions included in the Contract Documents and all reference standards in subsection 1.5 above.

## Health and Safety Requirements

### In accordance with requirements set forth by the OH&SA, CSA, and other regulatory agencies applicable to the construction industry [Consultant to amend this specification to include all relevant regulatory agencies by name] and manufacturer’s printed instructions, technical bulletins and manuals, the Contractor shall provide and require the use of protective and lifesaving equipment for persons working at the Site during construction operations. Special attention is to be paid to CSA Z259.2.2-14, Self-retracting Devices which has been updated to correct deficiencies in previous standards.

## Quality Assurance

### In general, the water storage facility shall be furnished by manufacturers having experience with a minimum of five similar elevated tank installations in the design, manufacture and construction of such facilities and their associated foundations. The manufacturer shall be able to demonstrate this experience through the successful completion of five other water storage facilities. This experience requirement shall apply to any subcontractors engaged in the work described in this Section.

## Measurement and Payment

*[Choose one of the following payment language provisions that best suits the individual project.*

*If this Section is not specifically referenced by an item in the Bid Form, please use the following language:*

.1 The work of this Section will not be measured separately for payment. All costs associated with the work of this Section shall be included in the Contract Price.

*OR If this Section is specifically referenced in the Bid Form, use the following language and identify the relevant item in the Bid Form:*

### All costs associated with the work of this Section shall be included in the price(s) for Item No(s). \_\_\_ in the Bid Form.

### If the work of this Section is to be measured and paid for by several different methods, please amend the standard wording given above to reflect the different methods of measurement and payment.]

# PRODUCTS

## General Requirements

### The Contractor shall supply all labour, materials and equipment necessary for the design, fabrication, delivery, erection, inspection and painting of the elevated water storage tank complete having a net working capacity of [\_\_\_\_\_] m3 [\_\_\_\_\_] Imp. gallons.

### The top water level (TWL) shall be set at an elevation of [\_\_\_\_\_ m Above Sea Level (ASL)]. The maximum working range and the minimum height from the ground to the low water level (LWL) shall be as specified on the Contract Drawings. The TWL, LWL and working range shall be related to the design drawings and documents and confirmed to comply with requirements for minimum fire storage, minimum pressure during maximum day and other design parameters including water age as well as other distribution storage facilities on the same district.

### The water storage facilities and accessories shall be amply proportioned, designed, manufactured, fabricated, delivered, erected, tested and disinfected in accordance with this Specification and the most recent applicable sections of AWWA standards including AWWA D-100-11 and shall include all associated piping and auxiliaries specified herein. In addition, the work shall include the design, supply and construction of foundations for supporting the structure.

## Design

### The structural design shall take into account all loads including dead load, water and ice loads, snow, wind and earthquake forces, and all secondary forces due to temperature, moisture, creep and shrinkage effects.

### In the design of steel tanks, the maximum allowable unit stresses in all members must be reduced to make proper allowance for elastic instability, buckling, wrinkling and excessive deformation in accordance with the allowable unit stresses given in the applicable sections of AWWA D-100-11.

### The design of the conical shell for buckling shall conform to the ECCS (European Convention for Constructional Steelwork, "Buckling of Steel Shells," European Recommendations, Fourth Edition) 1988 [Consultant to review the applicability of this reference and amend as required], and shall take into account the construction imperfections anticipated but within the limitations specified therein. However, under service loads, the factor of safety against buckling shall not be less than 2.0.

### The structure shall safely withstand, either separately or in combination, the loads and forces exerted by the following conditions listed herein.

### Design Loads:

#### Dead Load (weight of all permanent construction).

#### Water Load (weight of all water when tank is filled to TWL).

#### Snow load in accordance with the Ontario Building Code (Ss = 1.2 kPa, Sr = 0.4 kPa).

#### Wind loading in accordance with the Ontario Building Code based on 1/100 frequency from any direction against the tank when full or empty. These loads shall be applied to the design in accordance with the appropriate section of the Ontario Building Code (q 1/100 = 0.48 kPa).

#### Earthquake Zonal Velocity Ratio shall be 0.05 with Za = 1.0.

#### Tolerable Settlement of Buildings: The eccentricity of vertical and live loads that may occur due to out-of-plumb construction shall be assumed to be at least as 1 in 250 and to differential settlement of the structure on the founding soils.

### The effects of movements and loads from surface and wall ice thrusts shall be considered in conjunction with the rapid drawdown of stored water.

### The tanks supporting structure shall be designed in strict accordance with the Ontario Building Code and relevant sections of the OHSA (as amended) for safety related equipment and ease of access for maintenance, except for the following:

#### The probability factors for each of the following load combinations shall be equal to 1: DL + LL + Q DL + LL + T DL + T + Q DL + Q

#### The probability factor for the following load combination shall be equal to 0.85: DL + LL + T + Q where: DL = Dead Load LL = Live Load T = Maximum of Temperature or Eccentricity Load Q = Maximum of Wind or Earthquake Load

### The weight of the foundation and empty tank structure plus weight of the soil directly above the foundation shall be sufficient to resist the maximum net uplift occurring with the tank empty and the wind load, or earthquake load, as specified previously, acting in a direction causing the greatest net uplift on the foundation.

## Composite Elevated Water Storage Tanks

### General:

#### The elevated water storage tank shall be of composite-type design complete with all the accessories and piping required for its proper operation and maintenance. Detailed shop drawings of all the required accessories shall be stamped by a professional engineer licensed to practice in the Province of Ontario and shall be submitted to the Consultant and approved prior to fabrication.

#### The general requirements specified herein for elevated steel tanks supported on a concrete structure shall be supplementary to the standards detailed for the elevated tank design in subsection 2.2 of this Section and AWWA D-100-11 and/or AWWA D107-10, as applicable.

#### The overall storage facility shall consist of an aesthetically pleasing structure and shall generally resemble the shape shown on the Contract Drawings. The vertical height of the tapered portion of the tank shall be approximately 1/3 of the overall height of the tank. Any design where the ratio of the vertical height of the tapered cone section to the overall vertical height of the steel tank is less than 1/3 (0.33), including 0.32, shall not be allowed. The steel tank shall not be a simple cylinder supported on a concrete slab at the top of the concrete support shaft. The tank sidewall / roof interface shall include a “reverse cone” as shown on the Contract Drawings.

#### Stored water shall be in contact with painted or protected steel surfaces only. Concrete floors shall be lined with a steel membrane of 5.0 mm minimum thickness. Subsequent to vacuum testing of all welds for leakage, the gap between the floor plate of the tank and the concrete supporting slab shall be pressure grouted.

### Foundation:

#### The entire structure shall be constructed on a reinforced concrete foundation which shall be designed and constructed in accordance with Section 03300 – Cast-in-Place Concrete and as specified in this Section.

#### The foundation of the new tank structure shall be designed by the Contractor to support and maintain the structure in equilibrium without settlement, for all loads. The design of the foundation shall be subject to the review and acceptance by the Consultant.

#### In particular, the Contractor shall be responsible for the design and all work associated with footings, including excavation, de-watering (if necessary), formwork, concrete, reinforcing steel, granular fill material, grouting, backfilling and so forth; all of which shall be carried out in a workmanlike manner to the approval of the Consultant.

#### The design and construction of the foundation shall be in accordance with the Ontario Building Code and shall be of reinforced concrete conforming to the requirements of CAN/CSA A23.3-14, Design of Concrete Structures latest edition and Division 3 – Concrete.

#### [A geotechnical investigation has been carried out in the Contract area by [\_\_\_\_\_\_\_\_\_\_] as detailed in the [\_\_\_\_\_\_\_] Geotechnical Investigation Report, dated [\_\_\_\_\_]. The geotechnical report is provided with the Contract but does not form a part of the Contract Documents. No responsibility will be assumed by the Region for the correctness or completeness of the geotechnical report or the interpretation of the findings in the geotechnical report.]

#### [The Contract Price shall be based on the assumption that the elevated water storage facility shall be supported by a conventional foundation founded below all topsoil and fill on undisturbed natural soil at or below elevation [\_\_\_\_] m as detailed in the [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_] Geotechnical Investigation Report included as part of the Contract Documents. The safe net bearing pressure at or below elevation [\_\_\_\_] m shall be assumed at [\_\_\_] kPa. Should adjustments be required in the size or type of footing thereafter, the price will be adjusted subject to a negotiated amount.]

*[If soils investigation indicates more stringent foundation conditions, designers should amend this to suit. Consultant and York Region Project Manager to ensure incorporation of appropriate wording in the Supplementary Conditions clearly stating what is expected when soil investigations results in more stringent foundation requirements. Wording in the Supplementary Conditions must also be clearly stated that Contractor must rely on their own geotechnical reports and that York Region’s geotechnical reports are provided for information purposes only.].*

#### The design can be based on working stress or limit state design principals using the factors provided in the Geotechnical Report included in the Contract Document. The foundation design must address both ultimate limit states and serviceability states. In addition, load distribution shall be triangular across the bearing surface for both working stress design and limit states design.

#### The excavation shall be carried out by the Contractor such that the base of the excavation will be subject to approval of the Consultant prior to any construction of the footings or associated works.

#### After the Consultant has verified the safe net bearing pressure, and before any reinforcing steel is placed, the Contractor shall place a minimum 50 mm “mud slab” of 25 MPa concrete to extend 150 mm beyond the base slab or formed footings for the tank structure.

### Concrete Support Structure:

#### The concrete support structure shall have a minimum wall thickness of 200 mm. The support wall shall be vertically and horizontally reinforced. The maximum spacing of reinforcement shall be 300 mm. The minimum concrete compressive strength shall be 30 MPa at 28 Days. Design mix for support structure shall be submitted for approval as part of the design submission.

#### An analysis shall be carried out for the concrete pedestal in the vicinity of all openings. In particular, openings which have an included angle greater than 100 shall be subjected to a rigorous and thorough analysis consistent with CSA/CAN3 - A23.3-14, taking into account the stress concentrations and the diminished lateral support that exist in the vicinity of such openings. Additional reinforcement shall be provided above, below and on each side of the openings and shall be extended beyond the open boundaries to ensure a smooth flow of stresses around the opening.

#### Openings wider than 1,070 mm shall be subjected to a vigorous analysis taking into account the stress concentration and diminished lateral support that exists in the vicinity of such openings. Each side of the opening shall be designed as a column.

#### Openings 2,400 mm or wider shall be strengthened against vehicle impact and local buckling by means of an internal buttress located on each side of the opening. The buttress shall consist of a thickened, reinforced concrete wall section that is integrally formed and placed with the concrete support structure. The buttress section shall be a minimum 1,220 mm wide and 150 mm thicker than the nominal wall dimension. It shall extend a minimum distance of one-half of the opening width above and below the opening.

#### Form panels shall extend the full height of the concrete lift, using only vertical panel joints. These joints shall be sealed using closures which impart a continuous architectural effect to the completed structure. The top of each concrete lift shall be finished with a grade strip. The vertical and horizontal strips shall be proportioned and combined so as to impart a pleasing aesthetic pattern to the completed structure.

#### The initial 4.0 m of the exterior shaft finish shall be ground with a hand stone to impart a uniform appearance.

#### Dimensional tolerances of concrete construction shall conform to the requirements set out in subsection 3.3 below.

#### A quality assurance program to verify conformance shall be prepared by the Contractor and the results documented. As a minimum, the concrete support structure radius, plumb and thickness shall be verified by the Contractor in writing for each concrete lift at 45 degree intervals. An inspection report certified by the tank designer shall be provided to the Consultant on completion of the concrete support structure.

### Water Containment Structure:

#### The water containment structure will consist of a welded steel tank supported on the concrete support structure.

#### The steel tank shall be welded in its entirety, and shall be completely water tight including that portion above the high water level.

#### Steel Plates:

##### All steel plates shall be Grade 300W and conform to the current specifications of the CAN3-G40 series.

##### A minimum 1.6 mm corrosion allowance shall be provided in accordance with AWWA D-100-11 or AWWA D107-10 (as applicable). The corrosion allowance shall be referenced in the design calculations.

##### The minimum thicknesses including the specified corrosion allowance shall be as follows:

###### Cone / wall plates – 7.95 mm.

###### Roof plates – 6.35 mm.

###### Floor / membrane plates (fully supported) – 4.75 mm.

##### All members shall be designed to safely withstand the maximum stresses to which they may be subjected to during fabrication, erection and operation.

##### A mill inspection shall be undertaken prior to shipment of the steel plates to the Site by a certified independent Inspection Agency selected by the Contractor and approved by the Consultant. Payment for the mill inspection and Mill Test Report will be made by the Contractor. The Contractor shall provide written notification to the Consultant a minimum of three Working Days in advance of the proposed date when the mill inspection can be carried out prior to the shipment of the steel plates. Copies of Mill Test Reports shall be furnished to the Consultant by the Contractor as soon as they are available. Should the Contractor not provide the required notification as to when the mill inspection can be carried out, the Contractor shall pay for all inspection costs incurred by the Consultant and/or Region to verify the mill inspection reports.

#### Welding:

##### Except as otherwise provided for in this Section, all welds, materials and equipment shall conform to the latest issue of CSA Specification W59-2013 and W47. All welding procedures, types of electrodes, names of welders and welding equipment shall be detailed and submitted to the Consultant for approval prior to commencement of fabrication or construction.

##### Welding shall be carried out only by companies certified in accordance with Division 1 or 2 of the latest issue of CSA Standard W47.1-09 (R2014).

##### Welding electrodes shall be of E70 (E480) series low hydrogen type. All open containers of the electrodes shall be stored in drying ovens.

##### Only thoroughly dry electrodes shall be used. Welders shall be equipped with only enough electrodes for two hours of welding at any time.

##### All lap joints shall be welded both sides with continuous fillet welds.

##### All welds shall be smooth and even and sound throughout and shall have a minimum strength of 90 percent of that of the connecting plates. When requested by the Consultant, welding specimens shall be prepared by the Contractor and will be subjected to suitable tests to determine the quality and strength of the welds. Test welds shall be similar in every way to those made in the tank.

#### Fabrication:

##### Joints in compression members shall be planned to allow good contact between abutting ends. The welding edges of plates may be prepared by shearing, machining, gas-cutting or chipping.

##### Welding members and component parts must be straight and free from excessive buckles or warping. The misalignment of adjoining plates for butt joints subject to primary stress from the tank contents shall not exceed 10 percent of the thinner plate thickness or 1.6 mm, whichever is greater, and for butt joints not subject to primary stress, 20 percent of the thinner plate thickness or 3.2 mm whichever is greater. The separation of plates in lap joints shall not exceed 1.6 mm.

#### Reinforcement Around Openings:

##### All openings in the tank shell, suspended floor, riser plating and other locations which are subject to hydrostatic pressure, shall be reinforced in accordance with AWWA D-100-11, Section 3.13.

#### Tank Erection:

##### Steel tank erection procedures and general requirements shall be in accordance with AWWA - D100-11 or AWWA D107-10 for Composite Elevated Tanks.

##### Steel plates of varying thickness in dynamically loaded sections of the tank shall be aligned on the centre-line of the plates, not eccentrically. Steel backing of welds that are transverse to the direction of the computed stress shall be removed.

#### Accessories:

##### Unless otherwise noted in the Contract Documents, the standard accessories for the composite elevated tank shall be in accordance with AWWA D-107-10, appropriate section of AWWA D107-10 *[Consultant to amend as appropriate]*.

##### The minimum requirements specified in this Section shall be supplementary to the AWWA standards.

#### Access Manhole:

##### One access manhole, a minimum of 900 mm in diameter, shall be provided in the tank floor, and shall be hinged for access into the tank.

##### The access manhole shall extend above the tank floor to a minimum height of 100 mm above the outlet/drain piping.

##### A 600 mm inspection hatch shall be provided in the 900 mm manhole.

#### Roof Hatch:

##### One curbed roof hatch, 900 mm in diameter, shall be provided. The curb shall extend at least 100 mm above the tank roof.

##### The hatch cover lid shall be hinged and provision shall be made for interior locking with a heavy duty hasp.

##### The hatch cover lid shall extend for a distance of 50 mm down the outside of the curb.

#### Vent and Hatch:

##### A suitable hooded roof vent on a 500 mm diameter curbed roof hatch located near the centre of the roof, shall be furnished above the TWL.

##### The hatch cover shall be hinged and locked with a heavy duty hasp suitable for high security applications.

##### The vent shall have sufficient capacity to pass air so that at the maximum flow rate of water either entering or leaving the tank, a pressure differential will not be developed which will exceed the roof design loads.

##### The maximum flow rate of water entering the tank is [\_\_\_\_] L/s *[Consultant to insert value]*.

##### The maximum flow rate of water exiting the tank shall be determined by the tank designer based on an assumed break in the inlet / outlet at grade when the tank is full.

##### The overflow pipe shall not be considered to be a tank vent. The vent shall be hinged with provision made for locking, and shall be so designed and constructed as to prevent the entrance of birds, animals, and insects. Provide calculations to the Consultant to verify vent sizing.

#### Pressure/Vacuum Relief:

##### A pressure/vacuum relief mechanism shall be provided that will operate in the event of a tank vent failure. It shall be located on the tank roof above the maximum weir crest elevation and shall not be part of the vent.

##### The relief mechanism shall extend 150 mm above the tank roof. Design of the pressure/vacuum relief mechanism shall be such that it is not damaged during operation and it returns automatically to the normal position after relieving the pressure differential and is fully operational during severe winter conditions.

#### Ladders:

##### Ladders shall be provided inside the concrete support shaft and the access tube to give access to the roof of the tank. The ladders shall be provided with anti-ice devices/equipment for safety purposes.

##### The ladders in the concrete shaft shall be constructed of galvanized steel or aluminum and the ladders in the access tube shall be steel and painted to match adjacent steel material. The ladder inside the concrete shaft shall pass through and extend above the access landing and shall be equipped with a 1.2 m - 10 mm galvanized aircraft cable c/w snap hook (minimum requirements: 11 mm (7/16 inch), galvanized, 341 kg (750 pound) working load limit or approved equivalent) at end, Jaw End Swivel (hot dipped galvanized quenched & tempered type chain swivel *[Consultant to provide appropriate size]* or approved equivalent), and wire rope thimble (galvanized steel, hot dipped, meeting US Federal Specification FF-T-276b Type II, or approved equivalent).

##### Stainless steel and aluminum in contact with concrete shall be coated with two coats of bituminous paint.

##### All ladders shall be provided complete with a safety climb rail as described in subsection 2.3.5.7 - Safety Devices, below. In addition, swing-out rest seats and/or intermediate landings shall be provided as shown on the Contract Drawings. Swing out rest seats shall be spaced at a maximum of 9 m intervals on the ladder and shall be useable without removing the safety climbing device. Intermediate landings, if required, shall be made of aluminum and shall have railings and hinged floor grates. The ladder shall pass through the floor of each intermediate landing. Each landing shall be equipped with a permanently attached lanyard of sufficient length to safely disengage from the rail system on the ladder while standing on the landing without being exposed to the risk of falling.

#### Roof Ladder:

##### A roof ladder or stairway shall be provided on roofs having a slope greater than 5 in 12 (a measure of roof pitch – ratio of number of linear units of incline to each linear unit of run). For roof slopes from 2 in 12 to 5 in 12, there shall be a non-skid walkway and handrail. Materials in contact with the roof shall be steel painted using the same coating as the tank.

#### Safety Devices:

##### A fall prevention "TS Ladder Safety Rail" system shall be provided consisting of safety double clock trolleys and rails, complete with clamps for securing it to the ladder rungs, as manufactured by Tower Safety Group or an Approved Equivalent. The TS Trolley shall be equal to SK280 design which embodies a full swivel locking snap directly to a stainless steel brake pawl. *[Consultant to review and amend to cite current products meeting requirements]*

##### Submerged tracks shall be stainless steel, shallow profile. The non-submerged track shall be aluminum. Trolleys shall be for both aluminum and stainless track application, and shall have “shouldered” wheels.

##### Four sets of approved safety harnesses, equal to Miller by Honeywell International Inc., Front D-Ring Harnesses, Model SC 979 or an Approved Equivalent each with a lanyard clip and shock absorbing lanyard, Model SC 984 or an Approved Equivalent, shall be supplied. The lanyard shall be equipped with 38mm hooks at both ends and an adaptor (e.g. carabiner) with a 50mm opening for anchoring to larger diameter tie-offs.

##### A Confined Space Rescue System by Capital Safety or an Approved Equivalent as distributed by TS Group (Ontario) or by Levitt Safety shall consist of the following components:

1. Centre mounting sleeve welded in place on the top of the tank 762 mm (30”) from the centre of both roof hatches (or an approved equivalent or other model and installation that accomplishes the same intent).
2. 762 mm (30”) Lower mast or an Approved Equivalent.
3. Adjustable Offset Upper Mast or an Approved Equivalent.
4. Mounting bracket for winch or an Approved equivalent.
5. Digital 200 winch complete with 60m of SS cable or an Approved Equivalent.
6. Padded carrying bag for winch or an Approved Equivalent.
7. Carrying bag for mast or an Approved Equivalent.
8. Pro-pulleys or an Approved Equivalent.
9. Carabiners or Approved Equivalent.

#### Access Landing:

##### A galvanized steel or aluminum access landing with railings shall be provided beneath the tank floor and shall cover the full area enclosing the access manholes.

##### The landing shall be designed to permit climbers to remove or re-attach the safety hooks to the safety rail system without becoming exposed to the risk of falling and shall allow safe access to all hatches, ladders, pipes and conduits.

##### The minimum width of the landing shall be 2400 mm.

##### The landing shall be designed to accommodate the size and weight of subsequently installed multiple LDF7 communications cables.

##### The walking surface shall be open grate or checker plate with holes for water drainage.

#### Handrail:

##### A galvanized steel or aluminum handrail enclosing the roof hatch, vent and obstruction lights shall be provided, as shown on the Contract Drawings.

##### The minimum clear area enclosed by the handrail should be an area with a radius of 2.0m.

#### Rigging Devices:

##### Permanent interior and exterior rigging devices shall be provided for painting, inspecting and maintaining the tank structure and accessories.

##### A statement pertaining to the service load capacity of the rigging devices shall be provided, stamped by a professional engineer licensed to practice in the Province of Ontario and approved by the Consultant.

#### Overflow Piping:

##### The overflow piping shall be as shown on the Contract Drawings.

##### The overflow shall be set at 100 mm above TWL.

##### The outlet of the overflow shall extend a minimum 300 mm from the tank shell and shall be adequately supported in accordance with the AWWA D-100-11 and D107-10 standards.

##### The overflow pipe shall be submerged carbon steel pipe, Schedule 40 to ASME B36.10M-2004 standards and shall be epoxy coated to slow down corrosion inside the tank within the storage cell.

##### The overflow pipe shall be made in accordance with Schedule 10 of Gauge 11, Type 304L or 316L complying with ASTM A778-01(2009)e1 and pipe fittings manufactured in accordance with ASTM 774/A774M-14, pipe passivation in accordance with ASTM A380/A380M-13; or SS 316L in accordance with ASTM A312/A312M-14b for pipe and SS316L fittings in accordance with ASTM A403/A403M-13a thickness to suit working pressure below the storage cell *[Consultant to leave choice or define one option]*.

##### No stainless steel piping will be permitted within the storage cell. All piping shall be adequately braced in accordance with AWWA D100-11 standard. All welding to be completed by TIG methods, no MIG welding permitted.

##### The overflow pipe and intake shall have a capacity at least equal to the maximum inlet rate specified, with a head not more than 150 mm above the lip of the overflow and in no case more than 300 mm above the TWL where a side-opening type overflow is used.

#### Inlet/Outlet Piping:

##### The inlet/outlet piping shall be as detailed on the Contract Drawings. All piping installed under the foundation shall be concrete pressure pipe or ductile iron Class 52 pipe with restrained joints and shall be concrete encased. All piping in the valve chamber shall be type 316 or 316L stainless steel or ductile iron Class 52 with flanged connections. All nuts and bolts shall be cadmium plated.

##### All flanged connections between stainless steel riser piping and Ductile Iron (DI) piping, valves or fittings shall be completely insulated with flange insulation kits supplied by:

###### Interprovincial Corrosion Control Company Limited, Minlon Type E (full face)

###### An Approved Equivalent insulating gasket and insulating one-piece sleeve and washer.

##### Inlet and overflow piping fastened to the access tube shall be located in order to permit unimpeded access by sandblasting and painting crews.

#### Riser Piping:

##### The riser piping shall be gauge type 316 or 316L stainless steel in accordance with ASTM A312/A312M-14b thickness suited to design working pressure and adequately braced and in accordance with AWWA standards. Stainless steel pipe will not be permitted within the storage cell. Piping within the storage cell shall be steel and insulated from all dissimilar metals by the flange isolation kit approved by the Consultant. The minimum diameter for the riser piping shall be as shown on the Contract Drawings.

##### Where the riser piping is non-load bearing, flexibility to accommodate differential movements of the tank and riser foundation shall be included. This flexibility may be provided by an expansion joint or by riser layouts that have sufficient offset to be axially deformed without over stressing the riser, tank, support structure or foundation.

##### The riser piping shall be heat traced and insulated to ensure adequate protection against freezing at temperatures of minus 50 degrees Celsius. The electric heat tracing system shall only be applied to the inlet/outlet riser piping below the tank floor. The system shall be designed to prevent water freezing during the winter operation and shall be approved by the Consultant prior to installation.

#### Exterior Rails:

##### A continuous bar or tee rail near the top of the exterior of the concrete support structure shall be provided. The rail may be attached to the support wall or steel tank.

#### Interior Rails

##### Pipe couplings with plugs in the roof or other attachments that provide complete access for painting shall be provided.

#### Interior Rigging Attachments:

##### Rigging attachments located near the top of the support wall shall be provided for inspection and maintenance of all piping and equipment not accessible from platforms or floors. Comply with CSA Z259.2.2-14.

#### Exterior Doors:

##### Exterior entrance doors shall be provided in the concrete support structure as specified in Division 8 – Doors and Windows.

#### Painters’ Access Louvre:

##### A 900 mm diameter or 900 mm square manhole or access louver shall be provided in the concrete shaft for access to the external rigging devices. The manhole cover shall be insulated, hinged to open inside the tank above the access landing, and fitted with a removable aluminum louver and bird and insect screening.

#### Gin Wheel:

##### A gin wheel c/w shoulder eyebolt and insert (Safe Working Load (SWL) 23.1 kN) shall be provided on the underside of the bottom of the tank subject to the approval of the Consultant. The gin wheel and concrete insert shall be rated for a total load of 10 kN and be easily reached from the catwalk and from the upper landing where applicable. Supply 25 mm diameter new nylon rope, having length sufficient for both ends to simultaneously reach the ground level.

#### Valve, Chemical and Communications Rooms:

##### The valve chamber (valve room) and chemical room shall be located inside the concrete shaft as detailed on the Contract Drawings.

##### The chamber shall be designed by the Contractor to be supported on the foundation and/or the concrete shaft wall and shall be capable of carrying all specified and implied dead loads plus a super-imposed live load of 4.8 kN/m2. The superimposed live load of 4.8 kN/m2 applies to the design of both the chamber roof slab and the structural slab at grade.

##### Insulated exterior quality entrance doors shall be provided from inside the shaft to the respective rooms as specified in Division 8 – Doors and Windows. Do not provide double doors.

##### The valve chamber shall also be the location for manual re-chlorinating distribution water entering the tank. Re-chlorination capabilities, appurtenances, power supply and other facility requirements in accordance with the operational requirements set out in Division 13 - SCADA and Instrumentation and the Process Narrative/Process Control Narratives included in the SCADA appendices.

# EXECUTION

## Preparation of Subgrade

### The entire structure shall be constructed on a reinforced concrete foundation which shall be designed and constructed in accordance to Section 03300 – Cast-in-Place Concrete and as specified in this Section.

### All excavations shall be carried out by the Contractor. When the excavation is completed to the levels specified in the Contract Documents and ready to accept the working mat specified, it shall be inspected by an independent geotechnical consultant (“Geotechnical Consultant”) selected by the Consultant. *[The Consultant will procure and pay for the services of the independent Geotechnical Engineer]* The Contractor shall not place any concrete or reinforcing steel until the subgrade is reviewed and written acceptance is provided by the Consultant. The Consultant will make all arrangements for inspection by the Geotechnical Consultant.

### The Contractor shall provide notice to the Consultant and Region a minimum of two Working Days prior to the review of the subgrade and shall coordinate the Work so that the completion of excavation, inspection by the Geotechnical Consultant, and the placement of the working mat will occur on the same Day. The excavated subgrade shall not be left exposed more than 24 hours.

### Following the acceptance of the subgrade and verification of safe net bearing pressure by the Geotechnical Consultant, the Contractor shall remove any loose or unsuitable material and place a minimum 50 mm “mud slab” of 25 MPa concrete. The mud slab or working mat shall extend a minimum of 150 mm beyond the annular ring or formed footing for the tank foundation.

## Material Identification and Handling

### The Contractor is solely responsible for all shipping, handling and storage of materials and equipment in accordance with Section 01600 – Material and Equipment.

## Tolerances

### The Contractor shall ensure that the elevated storage facility is constructed in accordance to all standards *[Consultant to amend with list of relevant standards]* and as specified in this Section.

### A quality assurance program to verify conformance to all tolerances shall be prepared by the Contractor. The quality assurance program shall be submitted as part of the submittals and shall detail method(s) for verifying that all construction tolerances are met and detail remedial action plans to correct any work not meeting tolerances specified herein.

### The quality assurance program shall include, but will not necessarily be limited to, the daily verification of vertical alignment, radius and horizontal level during construction of the support wall. At the end of each day the Contractor will measure, and report to the Consultant, the following:

#### Vertical alignment and radius at eight points on the interior of the support wall. Points shall be located at 45° intervals.

#### Horizontal level at eight points at 45° intervals on the top of the form.

#### Wall thicknesses at eight points at 45° intervals.

### Vertical alignment and horizontal level shall be checked by the Contractor using a visible beam laser or equivalent as approved by the Consultant. An inspection report shall be prepared by the Contractor and submitted to the Consultant on completion of the Contract detailing all quality assurance measurements taken throughout construction. The report shall bear the stamp of a professional engineer licensed to practice in the Province of Ontario and shall certify that all work was constructed within the tolerances as specified in this Section. Work exceeding the tolerances shall not be accepted and shall be rectified at the Contractor’s cost.

### Tolerances for concrete and reinforcement shall comply with ACI 117 and the following:

#### Dimensional Tolerances for the Concrete Support Structure:

|  |  |
| --- | --- |
| Variation in Thickness: |  |
| Wall | -3.0% to + 5.0% |
| Dome | -6.0% to + 10.0% |
| Support Wall Elevation from Plumb: |  |
| In any 1.6 m of Height (1/160) | 10 mm |
| In any 15.2 m of Height (1/400) | 38 mm |
| Maximum in Total Height | 76 mm |
| Support Wall Diameter Variation | ± 0.4% |
| Not to Exceed | 76 mm |
| Dome Tank Floor Radius Variation | ± 1.0% |

#### The offset between adjacent pieces of formwork facing material shall not exceed the following:

|  |  |
| --- | --- |
| Exterior Exposed Surfaces | 3 mm |
| Interior Exposed Surfaces | 6 mm |
| Unexposed Surfaces | 12 mm |

#### The finish tolerance of trowelled surfaces shall not exceed the following when measured with a 3 m straightedge or sweep board:

|  |  |
| --- | --- |
| Exposed Floor Slabs and Sidewalks | 6 mm |
| Tank Floors | 19 mm |

## Welding

### All welding shall be conducted in accordance with CSA-W59.1-M and Division 1 or Division 2 of CSA-W47.1M using only Canadian Welding Bureau (CWB) approved welders and the requirement for 3rd party verification by the CWB. All welding procedures, types of electrodes, names of welders and welding equipment shall be detailed and submitted to the Consultant for approval prior to commencement of fabrication or construction.

### Welding electrodes shall be of E70 (E480) series low hydrogen type. All open containers of the electrodes shall be stored in drying ovens. Only thoroughly dry electrodes shall be used. Welders shall be equipped with only enough electrodes for two hours of welding at a time.

### All lap joints shall be welded both sides with continuous fillet welds.

### All welds shall be smooth and even and sound throughout and shall have a minimum strength of 90 percent of that of the connecting plates. When requested by the Consultant, welding specimens shall be prepared by the Contractor and will be subjected to suitable tests to determine the quality and strength of the welds. Test welds shall be similar in every way to those made in the tank. Any additional costs incurred for re-inspection due to welding deficiencies or scheduling delays shall be back-charged to the Contractor under the Contract by the Region.

### The Consultant has retained an independent Inspection Agency for Field Inspection to inspect both shop and field welds in accordance with AWWA D-100-11 Section 11, “Inspection and Testing”. Payment for the visual inspection will be made by the Region. The Contractor shall cooperate fully with the Inspection Agency, provide access to its facilities and submit all required information. The Contractor shall submit the credentials of its welders and approved welding procedures and coordinate the times when inspections and testing are to be carried out.

### Testing of welded joints shall include:

#### Radiographic Testing.

#### Vacuum Testing.

#### Ultrasonic Testing.

### All testing of welded joints shall be carried out prior to painting by an independent testing agency selected by the Region. Payment for radiographic, vacuum and ultrasonic testing will be made by the Region. The testing agency shall prepare a written report of the tests in accordance with AWWA D-100-11, applicable section of AWWA D-100-11, and submit one complete copy, including all radiograph negatives, to the Consultant.

### When a section of weld is shown by radiograph to be unacceptable, the Contractor shall repair the defective weld and all costs to re-inspect and/or re-test the repaired section shall be back-charged to the Contractor under the Contract by the Region.

### Should the quality of completed welds in the tank be in doubt, the Contractor shall, if and where ordered by the Consultant, cut out test pieces and shall patch the openings made in the plates. The number of such test pieces, excluding those which fail to show the specified strength, shall not exceed ten.

## Application of Protective Coatings

### The Contractor shall apply all protective coatings in accordance to Section 09960 – Painting of Steel Tanks and Appurtenances.

### The Region will hire an independent Inspection Agency to monitor the progress of the work and to ensure conformance to all specifications during both shop priming, if applicable, and field application. The Contractor shall cooperate fully with the Inspection Agency, provide access to its facilities and submit all required information. The Contractor shall coordinate the times when inspections and testing are to be carried out.

### All inspection and testing shall be carried out by the Inspection Agency selected by the Region. Payment for the testing will be made by the Region. The Inspection Agency will prepare a written report summarizing all inspections and tests in accordance with AWWA D-100-11 and D-102-11 and submit one copy of the complete report to the Consultant. Any additional costs incurred for re-inspections and/or re-testing due to deficient work or scheduling delays shall be back-charged to the Contractor under the Contract by the Region.

## Disinfection

### The Contractor shall test and disinfect all watermains, pipework and pipelines and structures constructed under this Contract. Disinfection of the water storage tank shall be performed in accordance with AWWA C652-11 in conjunction with the Procedure for Disinfection of Drinking Water in Ontario (As adopted by reference by Ontario Regulation 170/03 under the Safe Drinking Water Act) and Section 01750 – Disinfection and Testing of Water Retaining Structures and Process Piping. The exact method is to be reviewed and approved by the Consultant prior to commencing the work.

## Testing and Commissioning

### The testing and commissioning of the elevated water storage facility shall be performed in accordance with the requirements of Section 01810 – Equipment Testing and Facility Commissioning.

**END OF SECTION**